Cognitive Modeling for Closed-Loop Task Mitigation, Phase I

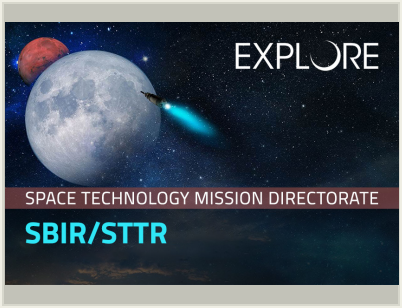
Completed Technology Project (2009 - 2009)

Project Introduction

As flightdeck equipment becomes more sophisticated and complex, operations become significantly more cognitively demanding. When tasks demands exceed the operator's available cognitive resources, potentially costly errors occur. A task mitigation system that is able to monitor the task and the operator's functional state (OFS) and implement task mitigation strategies before an operator becomes overloaded could significantly reduce errors and allow operators to work more efficiently. This proposal describes the development of a closed-loop task mitigation system that uses advanced regression techniques to identify the relationships between the OFS, the physiological measurements, the mission-related context, and the task mitigation strategies. To maximize accuracy, we use task analysis to develop a computational cognitive model of the planned mission profile, which is then used to train the regression model. The computational cognitive model describes the OFS as a continuous function along four dimensions: executive function, spatial working memory, verbal working memory and attention. The task analysis is also used to develop task mitigation strategies for each psychological dimension that assist the operator with task switching, maintaining awareness of multiple task "threads", and performing cognitively demanding tasks. Finally, the task mitigation strategies enable the system to dynamically allocate tasks among multiple operators.

Anticipated Benefits

The task mitigation system will be applicable in any environment, military or civilian, where human operators perform complex tasks over long periods of time, including UAVs, air traffic controllers, pilots and heavy equipment operators. The proposed work provides the following key benefits: 1) a closed loop system that monitors OFS, predicts performance decrements, selects the appropriate task mitigation strategy, and implements the task mitigation to maintain operator performance at optimal levels; and 2) the development of a task analysis process suitable for developing initial continuous models of OFS and identifying appropriate task mitigation strategies. The proposed research is in direct support of NASA's mission in multiple areas. The research supports the mission of the Aviation Safety group, by providing a system that identifies cognitive states that are likely to lead to operational errors and aids operators to optimize performance and minimize risk. In addition, the proposed research is directly applicable to work currently underway in Operator State Assessment. Finally, the proposed system could be useful for both training and operations of air traffic controllers.



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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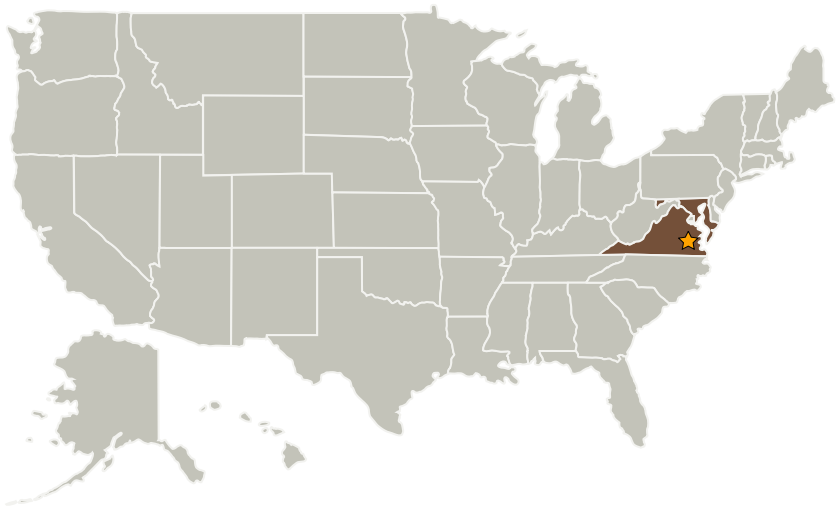
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Intelligent Automation, Inc.	Supporting Organization	Industry	Rockville, Maryland

Primary U.S. Work Locations	
Maryland	Virginia

Project Management

Program Director:
Jason L Kessler

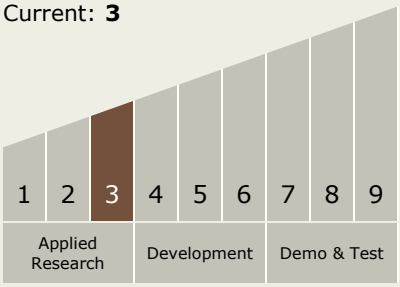
Program Manager:
Carlos Torrez

Project Manager:
Alan T Pope

Principal Investigator:
Christine Bredfeldt

Technology Maturity (TRL)

Start: **3**
Current: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.2 Structures
    - TX12.2.3 Reliability and Sustainment